

# **Analog Input**

## **Self-diagnosis Program**

### **Application Note**

#### **Outlines**

This application note describes the self-diagnosis program for the analog inputs.

The self-diagnosis program in this document is the library which is used to check a system including the analog input function.

This library supports the sample program with the peripheral driver of TXZ series enclosed, and should be used after it is overwritten to the sample program.

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## 1. Preface

This application note describes the self-diagnosis program to check the system using the analog input function.

This library code should be used after it is added (overwritten) to the published sample program.

The explanation of this document uses the TPM4K Group (1).

When the program is applied to a product, some appropriate modification may be necessary depending on the specifications of the product.

This sample program has been developed and evaluated under the conditions in the operation confirmation environment in “Self-diagnosis Program Application Note – Basic Setting”, and by using the TPM4K4A 1.0.0 sample program and the reference manual released in February in 2019.

## 2. Outline of Self-diagnosis Test Library

This self-diagnosis test library has been checked on the evaluation board.

The following self-test function is supported.

<b>Name</b>	<b>Description</b>
Analog input test	1: Three input voltages (VREFL, VREFH, and REGOUT1) are generated to check the input function. The converted values by the ADC are tested. 2: The analog voltages converted by the ADC are read at the analog input pins.

### 2.1. Self-diagnosis Sample Project

In the "Project\Examples\Safety" folder, the following sample project for the self-diagnosis library is placed.

<b>Project name</b>	<b>Operation</b>	<b>Utilized self-diagnosis library function</b>
AIN_Sample	Analog input test is executed. An analog input value is read. The test result is shown on the LED. In the build that DEBUGMSG is enabled, the ADC value of the measured analog value can be checked using the terminal output.	safety_AnalogIn() safety_AIN_PE4()

### 3. Details of Self-diagnosis Test Library

This section describes the details of the self-diagnosis test library function.  
 This sample program is a self-diagnosis program for the analog input function.  
 The following setting is an example when a product in the TPM4K group (1) is used.

The source code (.c file) of the self-diagnosis library is in the “Libraries\Safety\src” folder, and the header file (.h file) is in the “Libraries\Safety\inc” folder.

#### 3.1. Analog Input Test1

3 input voltages (VREFL, VREFH, and REGOUT1) are generated to verify the input function. Using the Conversion Result Storage Register10 (the ADC channel10), the AD-converted values are tested.

Source file: safety\_analog\_in.c  
 Header file: safety\_analog\_in.h  
 Used library: txz\_adc.c/.h, txz\_adc\_ch.c/.h, txz\_adc\_ex.c/.h, txz\_gpio.c/.h, and txz\_hal.c/.h

The “safety\_AnalogIn” function does not use any interrupts.

Function name	
bool safety_AnalogIn(uint32_t *result_word)	
Input parameter	
None.	-
Output parameter	
uint32_t *result_word	One of the following bits is set when the corresponding error occurs. bit0: Low voltage test error. bit1: High voltage test error. bit2: Divided voltage test error. When one of the errors is detected, the test is suspended. The remaining test is not done.
Return value	
bool	Result (true: success, false: failure)

\* If the return value cannot be confirmed for several seconds, it is supposed the test is not executed correctly.  
 The process of the test failure should be done.  
 When, however, the terminal I/O output display is used, it takes several seconds to complete the display.  
 The judgment of the test failure should be done by checking the display.

The ch16, ch17, and ch18 in the TPM4K group (1) are used as the reference voltage input pins for the ADC test.

ADC input channel	Function name (Signal name)
ch16	VREFH (5.0 V)
ch17	VREFL (0 V)
ch18	REGOUT1 (1.2 V)

The threshold voltages for judgment are the values of  $\pm 10\%$  of 0 V, 5 V, and 1.2 V, respectively, as shown below. These threshold values should be changed, if necessary.

Libraries\Safety\src\safety\_analog\_in.c

```
// threshold value, +- 10 %
#define MAX_PULLDOWN    (0x19a)    // 0.5 V (5.0 V x 10 %)
#define MIN_PULLDOWN    (0x0)      // 0.0 V

#define MAX_PULLUP      (0xffff)    // 5.0 V
#define MIN_PULLUP      (0xe66)     // 4.5 V (5.0 V x 90 %)

#define MAX_MIDVOL      (0x439)    // 1.32 V (1.20 V +10 %)
#define MIN_MIDVOL      (0x374)    // 1.08 V (1.20 V -10 %)
```

### 3.2. Analog Input Test2

The PE4/AINA14 pin should be set to analog input. The result value of the ADC should be read out.

Source file: safety\_analog\_in.c

Header file: safety\_analog\_in.h

Used library: txz\_adc.c/.h, txz\_adc\_ch.c/.h, txz\_adc\_ex.c/.h, txz\_gpio.c/.h, and txz\_hal.c/.h

The function “safety\_AIN\_PE4” does not use any interrupts.

Function name	
bool safety_AIN_PE4(uint32_t *p_value)	
Input parameter	
None.	
Output parameter	
uint32_t *p_value	Pointer to the valuable to which the ADC result value is written. When successful, a value in the range from 0 to 1023 is returned (0 = 0 V, and 1023 = 5 V).
Return value	
bool	Result (true: success, false: failure = ADC failure and others)

\* If the return value cannot be confirmed for several seconds, it is supposed the test is not executed correctly. The process for the test failure should be done. When, however, the terminal I/O output display is used, it takes several seconds to complete the display. The judgment of the test failure should be done by checking the display.

The test result is shown with the LEDs after all the tests finish on the evaluation board which was used to develop this test program.

LED1 (PJ0) lighting: All tests are successful.

LED2 (PJ2) lighting: Test1 fails.

LED3 (PJ4) lighting: Test2 fails.

## 4. List of Used Drivers

This test library uses the driver and the code in the project of the TPM4KxA\_v1.0.0 version.

### CMSIS library

Category	Source file name
Start-up	startup_TPM4KxA.s
System (Clock setting and others)	system_TPM4KxA.c

### Periph\_driver

Category	Source file name
GPIO	txz_gpio.c

### In the Project examples

Category	Source file name
BSP (Evaluation board support)	bsp.c
LED output	bsp_led.c



## 5. Reference Document

For development, refer to the following documents.

- Datasheet of each product
- Reference Manual
- Self-diagnosis Program Application Note - Basic Setting
- ARM® Cortex®-M4 Processor technical Reference Manual
- ARMv7-M Architecture Reference Manual

**6. Revision History**

<b>Revision</b>	<b>Date</b>	<b>Description</b>
1.0	2019-08-27	First release

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